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September 25, 2020

Melissa Sikes
Technical Administrator
Arizona Department of Water Resources
1110 West Washington Street, Suite 310
Phoenix, AZ 85007

RE: AMWUA Water Loss Control Technical Assistance & Training Program – Task 2 Complete (ADWR Contract 2019-3077)

Dear Ms. Sikes,

The Arizona Municipal Water Users Association (AMWUA) is pleased to inform you that Stage 1 of the AMWUA Water Loss Control Technical Assistance & Training Program (Program) has been completed. Progress on this task has been no easy feat, as the ongoing COVID-19 pandemic has disrupted many facets of operation in the water industry and strained the resources of municipal water providers everywhere. Fortunately, the AMWUA members and our subject matter expert, the Southwest Environmental Finance Center (SW EFC), have successfully pivoted to adapting the Program for the virtual environment.

Since February, the Program has organized 7 training sessions for the utilities which see typical attendance numbers of 40-50 participants. Additionally, the SW EFC continues to have regular sessions with individual utilities to provide personalized training and technical assistance for each city. Using the M36 methodology, water audits have been developed with each utility, and the SW EFC has produced extensive guidance and recommendations using the Level 1 validation methodology of the Water Research Foundation.

While many of the AMWUA members have had some exposure or experience with water loss control, participants already report having realized substantial value in improved measurement of their real and apparent losses, as well as identification of policies and practices that can be reviewed for improvement. We anticipate that the Program will continue to yield similar, successful results as the training and technical assistance progresses.

Please accept this submission as the Task 2 Deliverable pursuant to Contract 2019-3077. Also included is a "Stage 1 Summary Report" with more detail on the Program accomplishments to date, and an accompanying invoice. We greatly appreciate the opportunity to administer this Program as a result of ADWR's funding and collaboration. Please do not hesitate to reach out if you have any questions or comments.

Best,

Patrick J. Adams
Program Administrator

AMWUA Water Loss Control Training and Technical Assistance Program
Stage 1 Progress Report

Submitted to
Arizona Municipal Water Users Association

Submitted by
The Southwest Environmental Finance Center
Center for Water and the Environment
at The University of New Mexico

Program Funding provided by
Arizona Department of Water Resources

September 16, 2020

SOUTHWEST ENVIRONMENTAL FINANCE CENTER

ARIZONA DEPARTMENT OF WATER RESOURCES EST. 1980

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AVONDALE · CHANDLER · GILBERT · GLENDALE · GOODYEAR
MESA · PEORIA · PHOENIX · SCOTTSDALE · TEMPE

Executive Summary:

The Southwest Environmental Finance Center (SW EFC) at the University of New Mexico's Center for Water and the Environment contracted with the Arizona Municipal Water Users Association (AMWUA) to develop and provide a Water Loss Control Training and Technical Assistance Program (Program) to the AMWUA member utilities through a Sponsored Research Agreement dated January 30, 2020. Funding for this program was provided to AMWUA by the Arizona Department of Water Resources.

The utilities participating in the Program serve over 3.3 million people in the most densely populated portions of Arizona. The State of Arizona and the AMWUA Members are keenly aware that water is a precious and limited resource in the desert Southwest. Though the state of Arizona requires utilities to limit "lost and unaccounted for" water below a 10% threshold, the state's reporting requirements do not conform to industry standards and do not have a data validation component. Further, the state reporting requirements focus on real losses, but do not include an industry standard analysis of sources of loss, types of loss, losses classified as apparent loss, or an evaluation of water loss economics.

The Water Loss Control Training and Technical Assistance Program is designed to address these gaps by focusing on development and/or expansion of the utilities' internal capacity to document, evaluate, and address real and apparent water losses in their systems. This will be accomplished by using the industry-recognized and approved best management practices of the American Water Works Association's (AWWA) M36 methodology.

Prior utility experience with the M36 methodology varies, with some systems having had M36-based water audits completed prior to this Program's initiation and others having never engaged with the AWWA's M36 methodology or software. The Program is therefore designed to meet each utility where they are and to build on and enhance existing water loss control efforts by equipping AMWUA member utilities with the knowledge, skills, and experience necessary to implement the M36 water auditing methodology, including the methodology's more advanced practices, beyond the duration of the Program.

Although only seven of ten AMWUA members were initially expected to participate in the program, nine AMWUA members (Avondale, Chandler, Glendale, Goodyear, Mesa, Peoria, Phoenix, Scottsdale, and Tempe) have participated in Stage 1 trainings.

Initial accomplishments include: strong engagement by water utilities and a high volume of attendance at in-person and virtual events. Additionally, peer-to-peer exchanges have taken place that have facilitated valuable information-sharing between the participants. The audit process emphasizes learning about all parts of the system and that has enabled systems to develop a greater understanding of their overall processes and how water loss control fits in. As of this report, 7 systems have substantially complete audits, 1 is partially complete (data grades are incomplete), and 1 is in the beginning stages working to make progress. After reviewing

participating system audits and provided support data, SW EFC staff presented each of the participating systems with a Preliminary Validation Report using the Water Research Foundation's Level 1 Validation methodology. Each Report provides individualized recommendations with respect to data validity including:

- an evaluation of their individual audit data points and data grades;
- an explanation of what additional data and supporting documentation was required to a complete Level 1 Validation; and
- a comparison of each system's key performance indicators to the minimum, average and maximum values within AMWUA and to AWWA benchmark medians where available.

These reports were provided as a "road map" to guide the participating systems through the validation process. A webinar reviewing these reports was held on September 1, 2020 and was attended by 38 participating system staff members.

While there has been significant progress, there have also been some challenges. The main challenges relate to the need to go to a virtual environment, due to the onset of the COVID-19 pandemic, and the pace of progress by the participating utilities.

The SW EFC will continue to help the utilities refine their water audits and update their audit validation throughout Stages 2 and 3 of the Program, as additional analysis is performed and new data comes to light. This assistance will be concurrent with a continuation of training in Stage 2 that includes actions and strategies the AMWUA utilities can take to reduce non-revenue water. It will also include goal setting and the need to develop and employ a water loss control team to complete the work and measure progress.

Section 1: Summary of Stage 1 Accomplishments and Challenges

Summary of Accomplishments

Stage 1 consists of training the participating utilities on the M36 water audit methodology, working with the utilities to complete the data inputs and data grades for the audits, and conducting a level 1 validation process. The specific trainings are shown in Table 1 (on the following page) and are described in more detail in Section 2.

Table 1: Stage 1 Activities

Task	Date Completed	Attendance*			
		Number of Utilities Represented (of 9)	**Utility personnel attending**	**Non-utility personnel attending** (AMWUA; ADWR)	**Total attendees**
Stage 1 Introductory Webinar (Task 1A)	February 3, 2020	9	13	1	14
First Orientation Meetings (Task 1B (i))	February 22, 2020	9	40	1	41
Second Orientation Meetings (Task 1B (ii))	April 22, 2020	9	53	1	54
Stage 1 Report out Workshop (Task 1C - Originally referenced as "In-Person Workshop")	May 28, 2020	7	30	9	39
Preliminary Report Review Webinar	September 1, 2020	9	38	1	39

*attendance numbers do not include SW EFC team members

One of the accomplishments has been a high level of participation from the utilities for all training sessions, as can be seen above in Table 1. One particularly bright spot has been the peer-to-peer exchanges that have occurred during the in-person sessions as well as the virtual sessions. Utilities have been able to gain insight into procedures, policies, and activities that have been successful, and to learn about actions to avoid which have been less successful. During trainings, individuals have been able to share documents that can be modified and adopted at another utility, enhancing overall efficiency. This exchange will continue to be encouraged throughout Stages 2 and 3.

Another success has been the level of engagement with the SW EFC trainers in one-on-one sessions. Some of the utilities are participating in weekly calls while others participate in regular, but less frequent, discussions with the SW EFC. This engagement directly correlates to the level of progress in completion of the water audits. We will continue to encourage the remaining systems to achieve this same level of engagement to help them complete their audits and implement control measures.

The water audit process is one that encompasses the entire system, and completing an audit offers opportunities for utilities to learn from the process. The learning can include:

- the need to break down silos within the utility,
- a realization that activities that were thought to be done under a written policy actually are missing that policy,
- a discovery of an inequitable application of policies,
- missing data that was thought to be available, and
- a result that was different than what was expected.

Examples of the types of specific learning that have taken place by the AMWUA utility participants are provided in the list below.

- A system discovered that what it thought was routine source meter testing were actually only comparisons between installed inline meters owned by different parties.
- Several systems have determined that they don't have adequate data to calculate source meter correction factors because meters either haven't been tested, or the meters that have been tested only account for a small percentage of flow.
- A system discovered that some of its well flushing was occurring before production meters and some well flushing was occurring after production meters and, as a result, its production volume data was incorrect.
- A system realized that a systematic review of water loss components had never been done prior to conducting its first audit.
- A system realized that staff at their treatment facility were estimating the amount of water used in treatment because the output production meters had never worked correctly – this fact was common knowledge at the plant, but not known to management, and plans for the replacement of the faulty meter are being made.
- A system which had commissioned a water audit from a third-party contractor realized that they didn't understand how the audit had been conducted or what data went into it because they hadn't actively participated in the audit compilation.
- Several systems have determined that their customer meter testing is not as comprehensive as they had previously thought and that the data that is being collected is not used for any substantive analysis.
- Most systems have realized that they don't collect enough data to adequately estimate their unbilled unmetered use.
- Several systems have determined that they don't track fire department use or flushing in any meaningful way.
- One system realized that they don't actually know how many unmetered fire connections there are in their system, and that they have no way of tracking use in many of the connections that do have meters.
- The data grading process has demonstrated that policies and procedures (e.g. meter testing criteria) which were assumed to be documented were in fact not being recorded anywhere.
- Systems have discovered that they lack data redundancy – that some crucial data is held and managed by a single employee and is inaccessible without that employee, other data is only available in physical formats that have been lost in the past.
- Several systems have been unable to calculate a variable production cost or average customer retail unit cost without assistance.

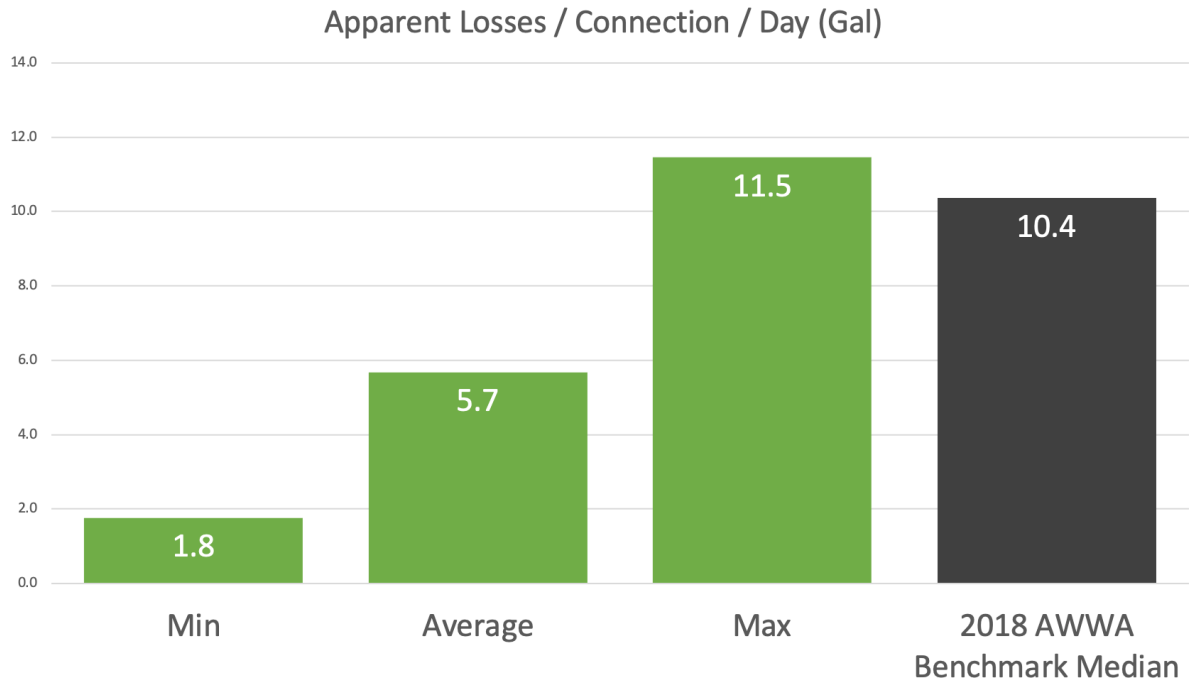
- Several systems have realized that data grading supporting documentation relating to policies and procedures is not readily available.
- A system realized that certain export customers didn't actually have detailed supply agreements.

Another significant accomplishment is the substantial completion of water audits by 8 of the 9 AMWUA systems. The one system that has not completed its audit as of the date of this report remains committed to the Program and is making progress to complete its audit. Each of these systems has been provided a detailed preliminary Level 1 validation report referenced above which included a review of the initial results of completed audits, summary statistics and a comparison to standard American Water Works Association benchmarks.

These summary statistics and comparisons are presented below. These results should be viewed as preliminary as the SW EFC expects refinement of these statistics to occur as a result of the analysis that will be undertaken during Stages 2 and 3 of the Program. Additionally, water loss control is a comprehensive program that encompasses more than what is included in a water audit.

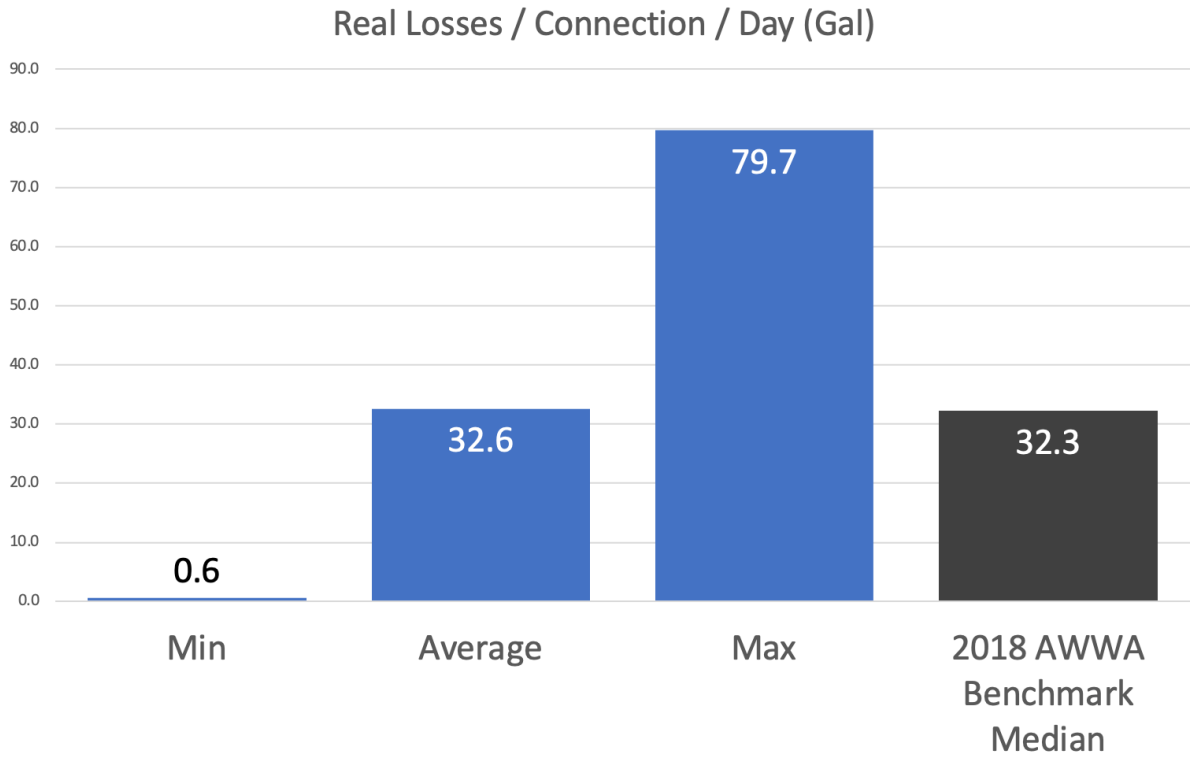
Apparent Losses per Connection per Day

Apparent losses per connection per day in the AMWUA systems are relatively low ranging from 1.8 to 11.5 Gal/Conn/Day, with an average of just less than 6 Gal/Conn/Day. While the average value compares favorably with the AWWA 2018 Benchmark Average of 10.4 Gal/Conn/Day, this is a potential area for improvement, particularly for Chandler and Goodyear which appear to have apparent losses on the higher end of the range.



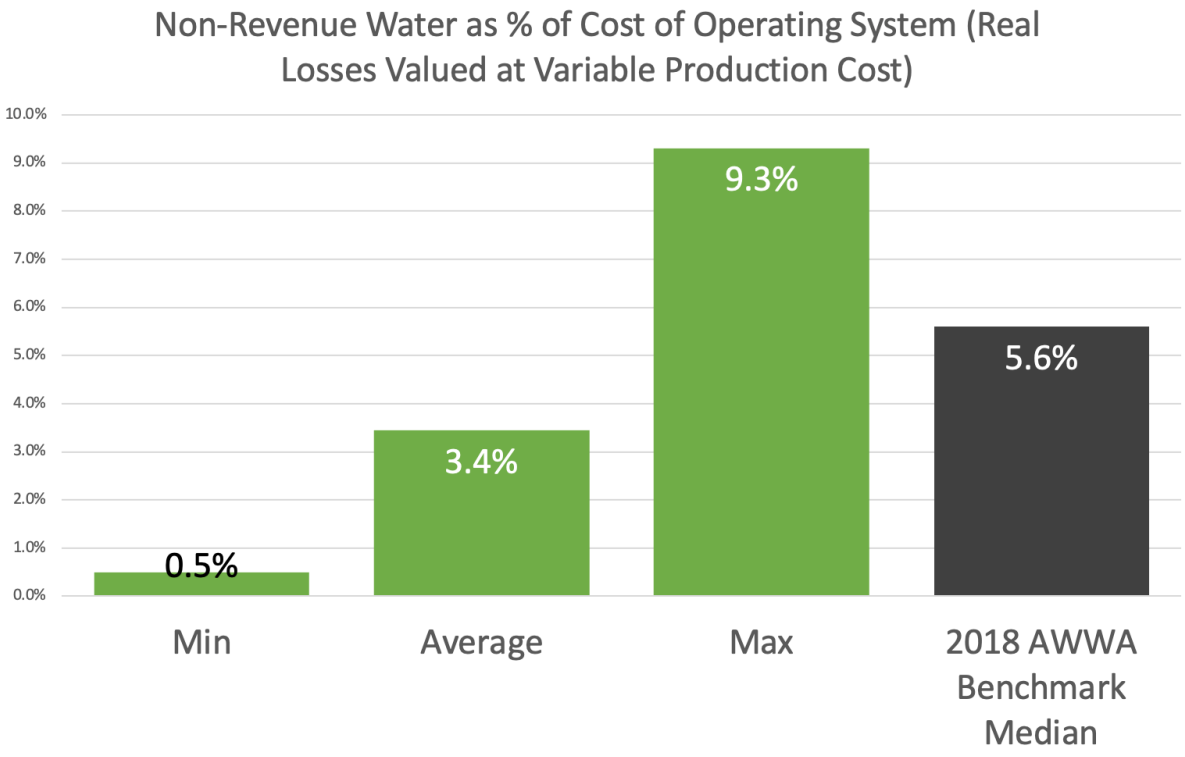
Real Losses per Connection per Day

Real losses per connection per day in the AMWUA systems are spread across a relatively large range, from less than 1 to 79.7 Gal/Conn/Day, with an average of 32.6 Gal/Conn/Day. The average AMWUA real losses per connection per day compare favorably with the AWWA 2018 Benchmark Average of 32.3 Gallons, but the results at the low and high ends of the scale should be viewed with some skepticism until Stage 2 component analysis helps to confirm or refute these preliminary results.



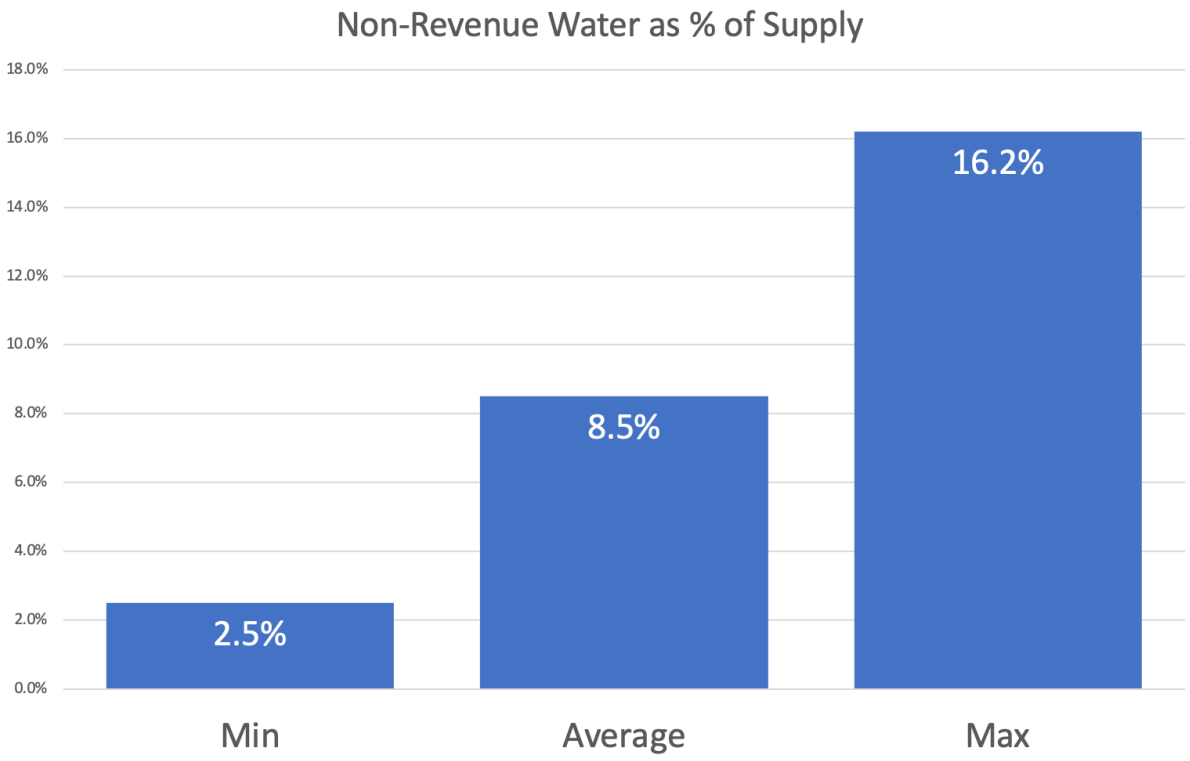
Non-Revenue Water as a Percentage of Operating System Costs

The 2018 AWWA Benchmark median value for Non-Revenue Water as a Percentage of Operating System Costs was 5.6%. While the values in the AMWUA compiled water audits range from less than 1% to just over 9%, the AMWUA average is 3.4% and only one system exceeds the AWWA Benchmark for this performance indicator. Further review of additional data developed during Stage 2 component analysis will help confirm these preliminary results.



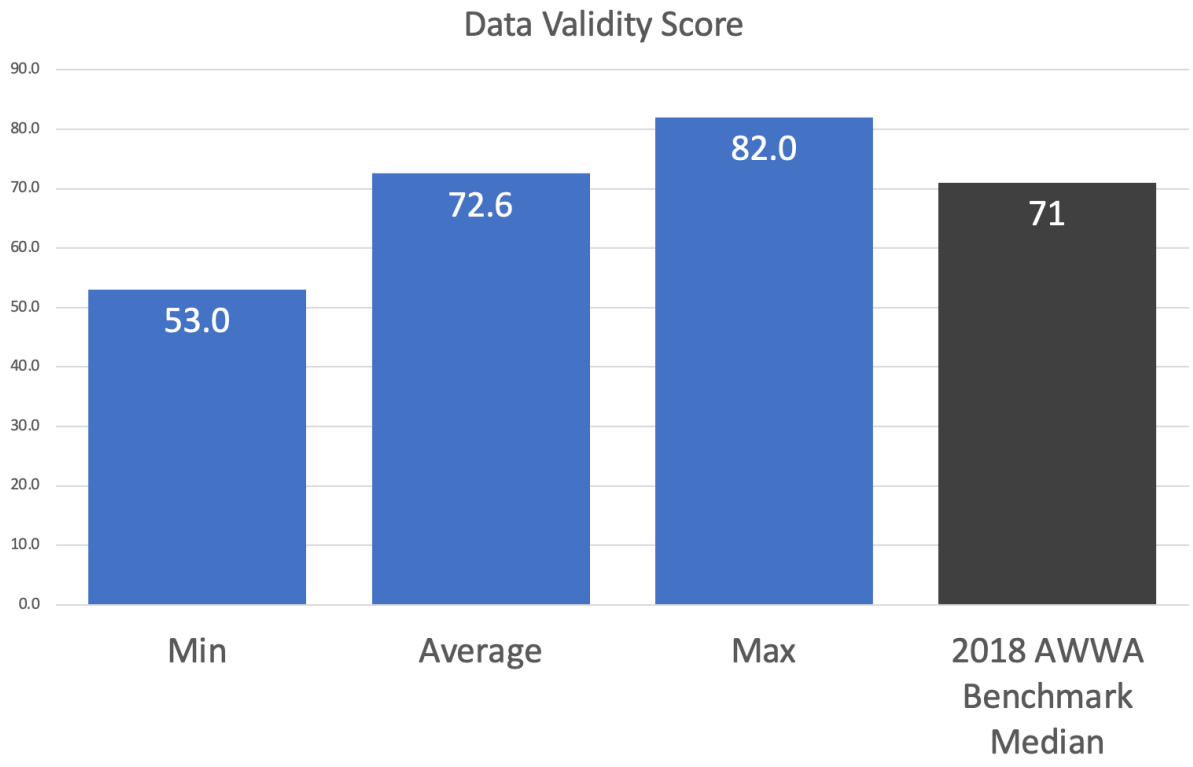
Non-Revenue Water as a percentage by Volume of Water Supplied

This metric is likely to be phased out in the next iteration of the water audit software, but we have included it to compare with the 10% "lost and unaccounted for" water threshold set by the State of Arizona. As the graph below indicates, NRW as a percentage of supply (which includes both real losses and apparent losses) is, with one outlier, generally near or below 10%, corroborating state filings. Where there may be differences between the audits and the state filings, this is most likely caused by the differences between reporting requirements as these two methodologies are not calculated in the same manner. As part of the ongoing analysis in the Program, differences between the filings and the audits can be explored.



Water Audit Data Validity Score

The graph below charts AMWUA Member water audit Data Validity Scores which range from 53 to 82 and average 72.6. Given that most of the systems in AMWUA are water auditing novices, these are relatively high scores and are indicative of systems that have solid policies, practices and procedures in place. The scores compare very favorably with the 2018 AWWA median benchmark of 71 and the data grades that the SW EFC has seen in systems that have much more water auditing experience. However, these Data Validity Scores primarily reflect utility self-assessments. While SW EFC staff have been able confirm many of these results, some individual data grades must be viewed with a degree of skepticism because the back-up documentation supporting them remains incomplete. The grades may be reduced if the proper information cannot be documented.



Challenges

While there have been many successes in the Program thus far, there have also been challenges. One of the largest is having to change the in-person events and technical assistance to a virtual mode due to the COVID-19 pandemic. This was a major change in how the Program was envisioned but the participants have adjusted well and the level of engagement and participation has remained high. We will continue to seek ways to encourage peer-to-peer exchanges and workshop activities in the virtual environment.

The pace at which the utilities have been able to complete the water audits and gather the necessary supporting documentation has been slower than anticipated. This may be a combination of working from home, staffing issues, the pandemic, and the importance with which water loss is viewed at this time. We will continue to support the utilities with technical assistance as much as possible to encourage them to complete the activities.

Section 2: Description of Stage 1 Activities

Introductory Webinar

Stage 1 of the Program commenced with an Introductory Webinar titled, "AMWUA Water Loss Control Training and Technical Assistance Kickoff," held on Feb 3, 2020. The introductory webinar included the following topics:

- The AWWA's M36 Water Audit Methodology, including the water balance and data grading;
- Basic requirements for forming a cross-functional water loss control team, including potential types of participants and activities to represent;
- An overview of data required to complete and validate an M36 water audit;
- Information about the SharePoint directories to store and share data; and
- Water audit resources available to AMWUA members.

A recording of the webinar was made available to each system's water loss team and AMWUA staff via the system-specific SharePoint directories established by the SW EFC (detailed below).

Data Transfer and Storage

Concurrently with the Introductory webinar, each Member's water loss control team was given access to a remotely available, secure SharePoint directory that was set up on an SW EFC server. AMWUA staff was also given access to each of the Members' directories.

These SharePoint folders are used to disseminate training materials, such as webinar recordings, tools, and software. They also serve as data repositories for water audit data and associated supporting information to facilitate analysis by SW EFC staff. Participating utilities have read/write access to their individual directories and can add data or modify the folder

structure as needed. Each system has successfully accessed their SharePoint directory, and many have added the necessary data to the repository.

First Orientation Meeting

The First Orientation Meeting occurred on February 26, 2020 at AMWUA's facilities and focused on several key concepts:

- Explaining the overall water loss control program (a water loss control program is much bigger than just an audit);
- Setting goals for water loss control;
- Establishing a water loss control team;
- Understanding what a water audit is and what it isn't, and its overall role within the comprehensive water loss control program; and
- Explaining basic water audit concepts.

This training was held in plenary session format for the morning, while for the afternoon there were two concurrent options for participation: Tracks A and B. The intent was to accommodate any attendees who had a thorough understanding of the water audit process and did not need training on developing inputs.

- Track A was intended for beginners or anyone needing a water audit refresher. The session covered:
  - data needed to complete an AWWA M36 water loss audit;
  - data grading for a water balance;
  - accessing the AWWA Water Audit Software;
  - data collection needs; and
  - common data errors and collection issues.

- Track B was intended to be more free-flowing, to encourage more peer-to-peer, direct interaction. This session was designed for participants with more knowledge of water loss auditing. It discussed setting goals as well as the complexity of an overall water loss control program. It enabled utilities to ask direct questions of each other and receive feedback on what worked well and not so well for the various utilities.

The choice between Track A and Track B was left up to each participant. Some systems sent representatives to both tracks while other systems had all attendees in one track or the other. Approximately two-thirds of participants were in Track A and one third joined Track B.

The PowerPoint presentations were made available to each system's water loss team SharePoint, and the attendee list, and copies of the training materials provided during the first Orientation Meeting were provided to AMWUA.

Second Orientation Meeting

The Second Orientation Meeting was held on April 22, 2020. Due to the COVID-19 pandemic, this meeting was presented in a virtual format using Zoom.

Topics covered in the Second Orientation Meeting included the AWWA's M36 methodology for assigning data grades to individual data points in the water audit, the audit's calculation of the overall Water Audit Data Validity Score ("DVS"), and an overview of Level 1 water audit validation as detailed in the Water Research Foundation's 2016 "Level 1 Water Audit Validation: Guidance Manual." The supporting documentation requirements to conduct validation was also discussed. It was important for participants to understand that Water Audit Validation requires an actual review of relevant system policies and procedures, not just a statement that they exist.

In addition, participants were introduced to two SW EFC tools to assist them in the data grading procedure. The approach embedded into the water audit software is somewhat difficult to use and often leads to errors in how the data grades are determined. To address these concerns, the SW EFC developed alternatives: a paper-based Water Audit Data Grading Sheets (which present the water audit's data grading criteria in an easy to use format), and an Excel-based Data Validity Worksheet that allows users to answer specific questions related to each audit data point and have their data validity scored automatically. Each tool, when applied correctly, should yield the same result as the AWWA Water Audit Software. There may be slight variations because of subjectivity that is inherent in the process (e.g. whether something is done occasionally or routinely is open to interpretation) but these slight differences are of little concern. Both tools were made available to participants via the SW EFC SharePoint site.

To improve the learning and interactivity, virtual breakout rooms were used. During this time, the participants in the break-out groups had a chance to try out some of the data grading tools, look at the sensitivity of different grades, and share with each other. After the breakouts, there was an opportunity for reporting out the results of the break-out sessions.

The Second Orientation Meeting was recorded, and a link was provided to the participating systems and AMWUA through the SharePoint site along with the agenda, PowerPoint presentations, and training materials. The attendee list was also provided to AMWUA.

Report Out Workshop (Originally Titled "In-Person Workshop")

The Report Out Workshop was, in consultation with AMWUA, conducted in a virtual format on May 28, 2020. The session included a virtual roundtable in which each participating system provided a review of their progress to date on the audit and/or goal setting activities. Participants representing seven of the participating AMWUA systems attended and an additional system, who was not able to attend, provided data for the SW EFC to share during the report out. One system did not attend or provide data for this session.

Each Member was given 5 to 10 minutes to report on their progress. Although all of the systems had made some progress on developing their water audit data inputs, in many cases, the progress was somewhat or substantially slowed by resource constraints related to the COVID-19 pandemic.

The session was recorded, and a link was provided to the participating utilities and AMWUA through the SharePoint site. The participant list and poll question results were provided to AMWUA.

Summary of Technical Assistance Provided

The Stage 1 technical assistance (TA) focused on development and preparation of water system audits, as well as addressing any specific requests for information or assistance from water systems regarding any other water loss control concerns. TA was made available to all participating systems from the inception of the Program. The engagement level of individual Member utilities varied from weekly, on-going, active engagement, to little engagement at this time.

Initially, the assistance was intended to be provided in person, and the first assistance was completed this way with a few systems in February. Since the onset of the COVID-19 pandemic and resultant travel restrictions, technical assistance has moved to a virtual, remote model using phone, e-mail, and teleconferencing applications, such as Zoom.

Among the systems with little or no prior experience with the M36 methodology, there is a strong correlation between system engagement with SW EFC staff for technical assistance and progress made on water audits.

Section 3: Description of Stage 2 Next Steps

Stage 2 builds off of the water audits in Stage 1 by providing information regarding actions utilities can take to address the various components of non-revenue water. There will also be opportunities for systems to use component analysis to gather additional data to verify portions of the audit and develop action plans for addressing water losses. In addition to discussing real and apparent losses, this portion of the training program will go over goal setting and measuring progress towards meeting goals.

The table below lists the topics to be presented during the training sessions of Stages 2 and 3. Activities that would have been presented in an in-person workshop format have been re-formatted into 2-hour and “2+1” hour sessions, with the final hour of “2+1” sessions devoted to “ask the expert” style Q & A sessions for the participating systems, and a chance for less formal peer-to-peer exchanges. Technical assistance will continue to be provided for the duration of the Program.

Stage	Virtual Training Name	Length (hrs)
2	Introductory Webinar (July 22, 2020)	1
2	Goal Setting (September 15, 2020)	2
2	Water Loss Control Activities - Apparent Loss (October 6, 2020)	2 + 1
2	Water Loss Control Activities - Real Loss	2 + 1
2	Leakage Component Analysis	2 + 1
3	Introductory Webinar (optional)	1*
3	Reevaluating Goals	2
3	Economics of Water Loss	2 + 1
	Report Out / Next Steps / Wrap Up Session	2
	Total:	16*+4

The Stage 2 kickoff webinar, which included a review of Stage 1 progress and an overview of upcoming training and activities was presented on July 22, 2020. The webinar was recorded and was made available to all of the participating systems and AWMUA on July 23, 2020 (along with the PowerPoint Presentation) so that it could be shared with staff members who were unable to attend the live session. The registration list was provided to AMWUA.

Stage 3 Activities

Stage 3 activities will focus on the economics of water loss control activities, benefits of activities, and a reevaluation of the goals that were set in Stage 2.